

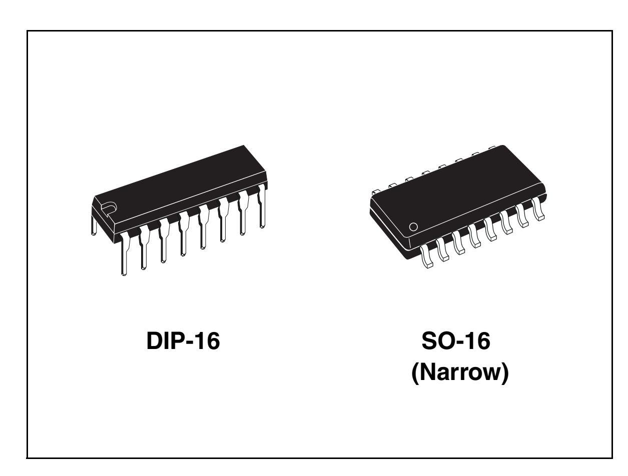
ULN2001, ULN2002
ULN2003, ULN2004

Seven Darlington array

Datasheet — production data

Features

- Seven Darlingtons per package
- Output current 500 mA per driver (600 mA peak)
- Output voltage 50 V
- Integrated suppression diodes for inductive loads
- Outputs can be paralleled for higher current
- TTL/CMOS/PMOS/DTL compatible inputs
- Inputs pinned opposite outputs to simplify layout



Description

The ULN2001, ULN2002, ULN2003 and ULN 2004 are high voltage, high current Darlington arrays each containing seven open collector Darlington pairs with common emitters. Each channel rated at 500 mA and can withstand peak currents of 600 mA. Suppression diodes are included for inductive load driving and the inputs are pinned opposite the outputs to simplify board layout.

The versions interface to all common logic families:

- ULN2001 (general purpose, DTL, TTL, PMOS, CMOS)
- ULN2002 (14 - 25 V PMOS)
- ULN2003 (5 V TTL, CMOS)
- ULN2004 (6 - 15 V CMOS, PMOS)

These versatile devices are useful for driving a wide range of loads including solenoids, relays DC motors, LED displays filament lamps, thermal printheads and high power buffers.

The ULN2001A/2002A/2003A and 2004A are supplied in 16 pin plastic DIP packages with a copper leadframe to reduce thermal resistance. They are available also in small outline package (SO-16) as ULN2001D1/2002D1/2003D1/ 2004D1

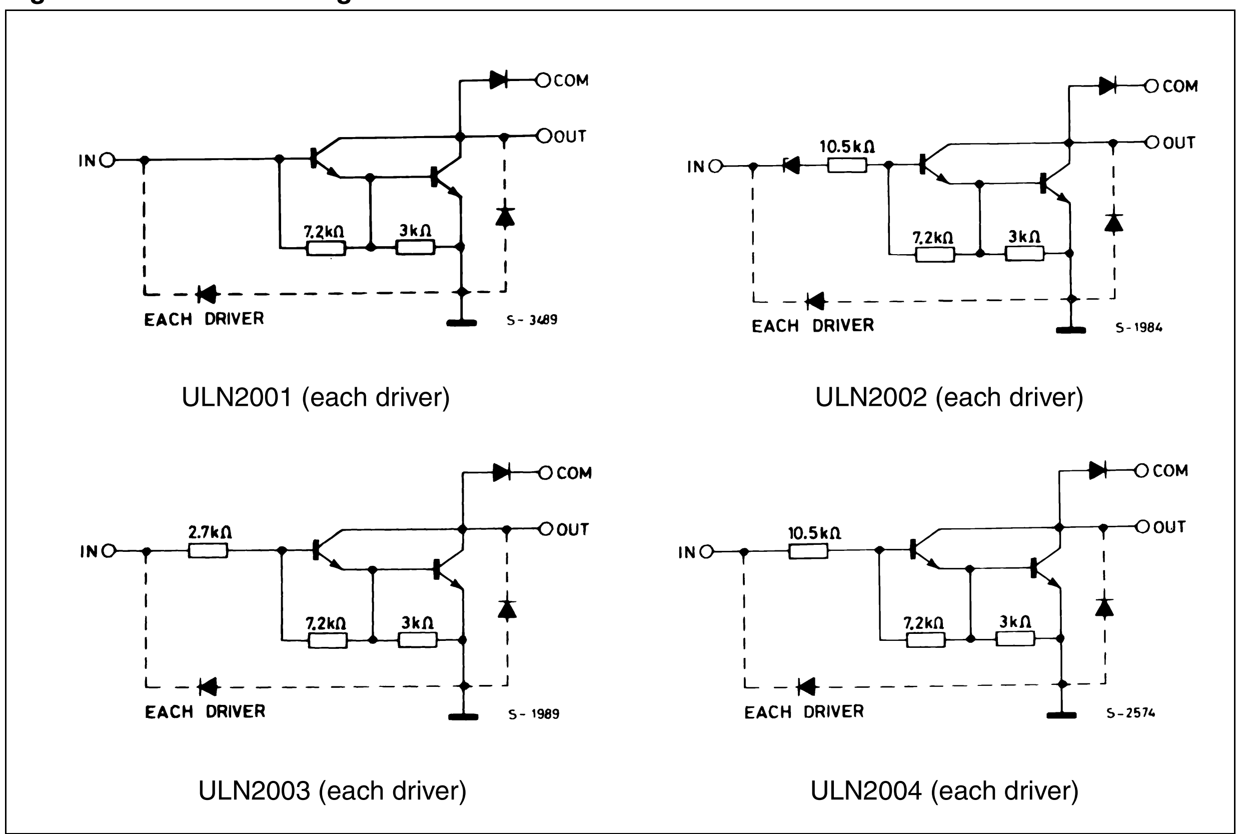
Table 1. Device summary

Order codes	
ULN2001A	ULN2001D1013TR
ULN2002A	ULN2002D1013TR
ULN2003A	ULN2003D1013TR
ULN2004A	ULN2004D1013TR

Contents

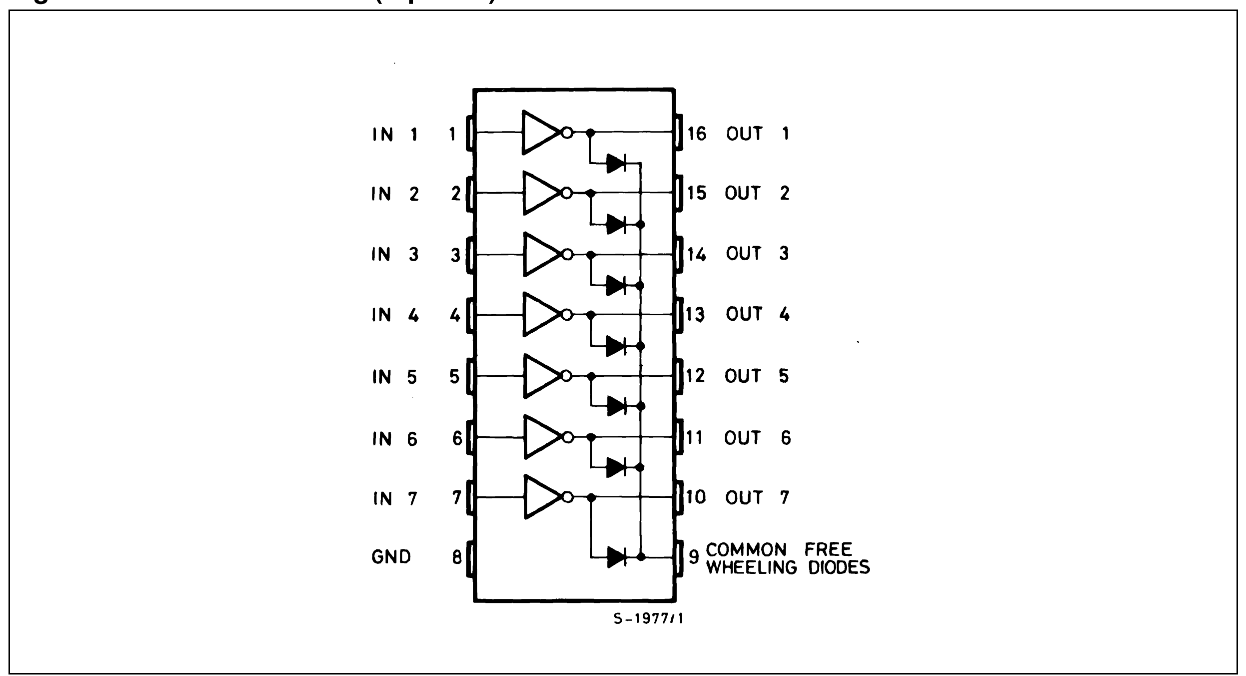
1 Diagram

Figure 1. Schematic diagram



2 Pin configuration

Figure 2. Pin connections (top view)



3 Maximum ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_O	Output voltage	50	V
V_I	Input voltage (for ULN2002A/D - 2003A/D - 2004A/D)	30	V
I_C	Continuous collector current	500	mA
I_B	Continuous base current	25	mA
T_A	Operating ambient temperature range	- 40 to 85	°C
T_{STG}	Storage temperature range	- 55 to 150	°C
T_J	Junction temperature	150	°C

Table 3. Thermal data

Symbol	Parameter	DIP-16	SO-16	Unit
R_{thJA}	Thermal resistance junction-ambient, Max.	70	120	°C/W

4 Electrical characteristics

T_A = 25 °C unless otherwise specified.

Table 4. Electrical characteristics

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
I_{CEX}	Output leakage current	V_{CE} = 50 V, (*Figure 3.*)			50	µA
		T_A = 85°C, V_{CE} = 50 V (*Figure 3.*)			100	
		T_A = 85°C for ULN2002, V_{CE} = 50 V, V_I = 6 V (*Figure 4.*)			500	
		T_A = 85°C for ULN2002, V_{CE} = 50 V, V_I = 1V (*Figure 4.*)			500	
$V_{CE(SAT)}$	Collector-emitter saturation voltage (*Figure 5.*)	I_C = 100 mA, I_B = 250 µA		0.9	1.1	V
		I_C = 200 mA, I_B= 350 µA		1.1	1.3	
		I_C = 350 mA, I_B= 500 µA		1.3	1.6	
$I_{I(ON)}$	Input current (*Figure 6.*)	for ULN2002, V_I = 17 V		0.82	1.25	mA
		for ULN2003, V_I = 3.85 V		0.93	1.35	
		for ULN2004, V_I = 5 V		0.35	0.5	
		V_I = 12 V		1	1.45	
$I_{I(OFF)}$	Input current (*Figure 7.*)	T_A = 85°C, I_C = 500 µA	50	65		µA
$V_{I(ON)}$	Input voltage (*Figure 8.*)	V_{CE}= 2 V, for ULN2002 I_C = 300 mA for ULN2003 I_C = 200 mA I_C = 250 mA I_C = 300 mA for ULN2004 I_C = 125 mA I_C = 200 mA I_C = 275 mA I_C = 350 mA			13 2.4 2.7 3 5 6 7 8	V
h_{FE}	DC Forward current gain (*Figure 5.*)	for ULN2001, V_{CE} = 2 V, I_C = 350 mA	1000			
C_I	Input capacitance			15	25	pF
t_{PLH}	Turn-on delay time	0.5 V_I to 0.5 V_O		0.25	1	µs
t_{PHL}	Turn-off delay time	0.5 V_I to 0.5 V_O		0.25	1	µs
I_R	Clamp diode leakage current (*Figure 9.*)	V_R = 50 V			50	µA
		T_A = 85°C, V_R = 50 V			100	
V_F	Clamp diode forward voltage (*Figure 10.*)	I_F = 350 mA		1.7	2	V

5 Test circuits

Figure 3. Output leakage current

Figure 4. Output leakage current (for ULN2002 only)

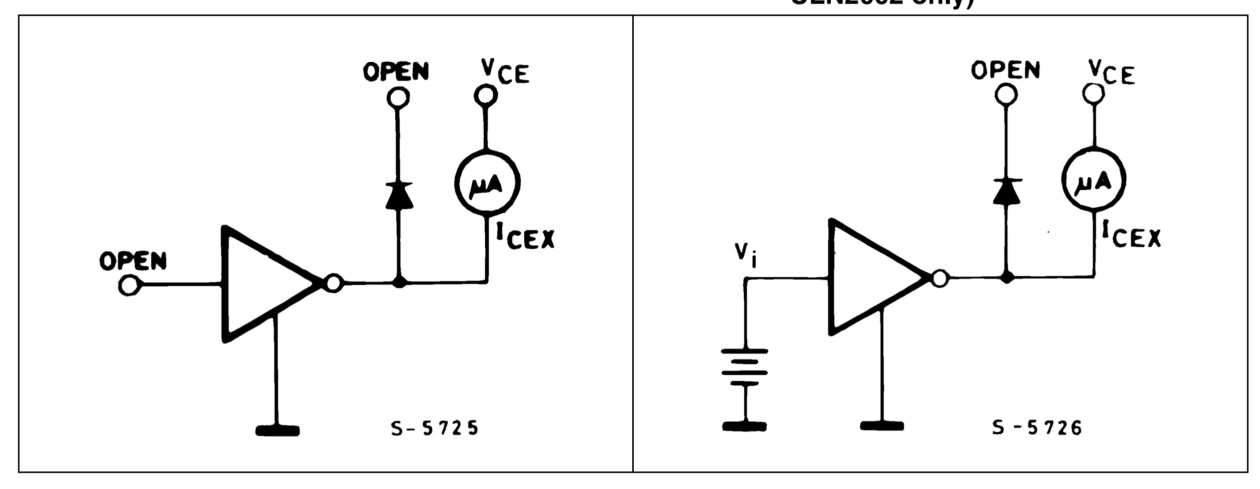


Figure 5. Collector-emitter saturation voltage

Figure 6. Input current (ON)

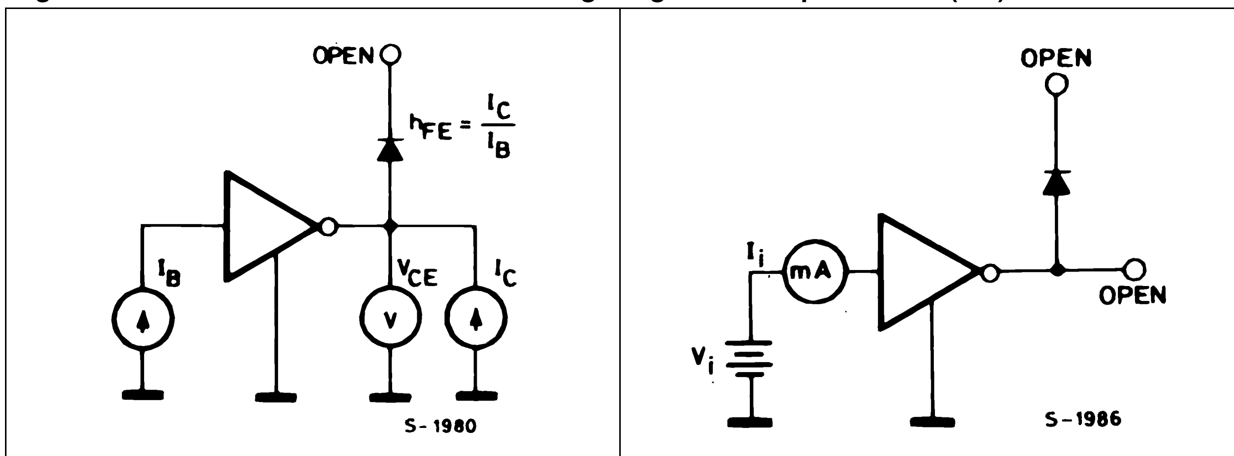
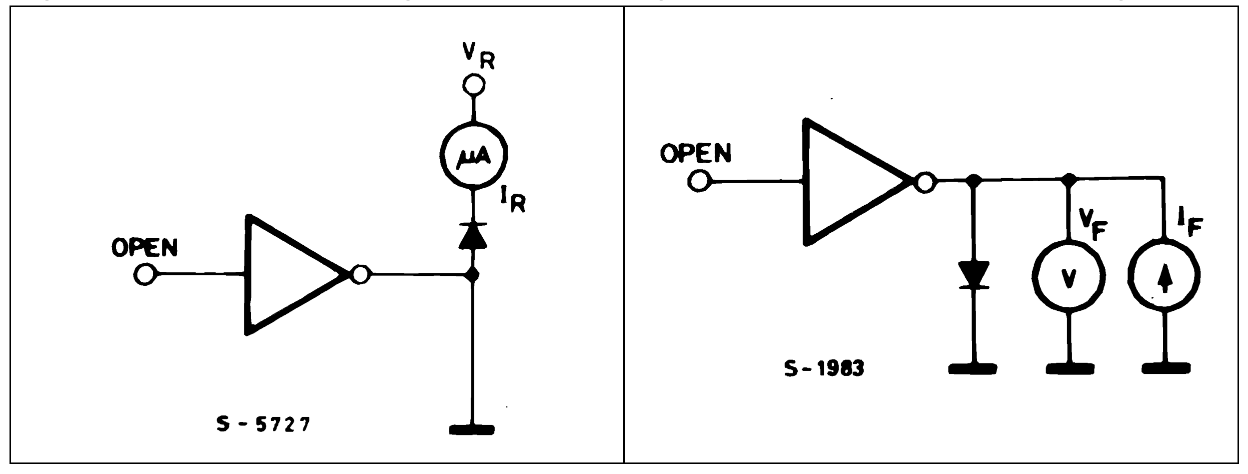


Figure 7. Input current (OFF)

Figure 8. Input voltage

Figure 9. Clamp diode leakage current

Figure 10. Clamp diode forward voltage



6 Typical performance characteristics

Figure 11. Collector current vs. saturation voltage (T_J = 25°C)

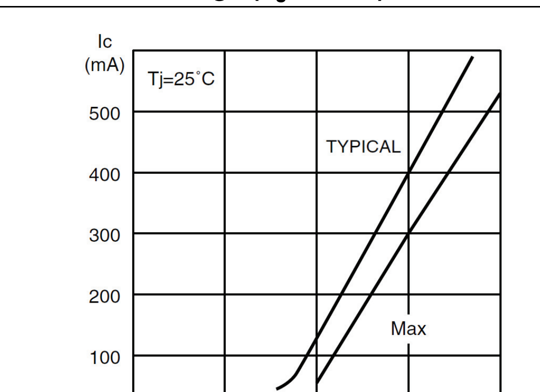


Figure 12. Collector current vs. saturation voltage

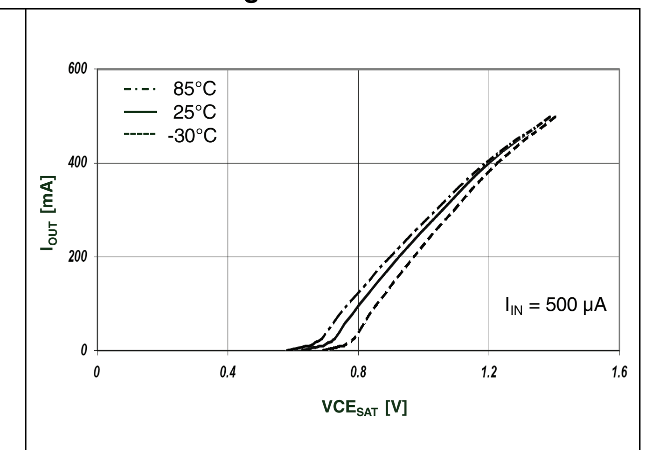


Figure 13. Input current vs. input voltage

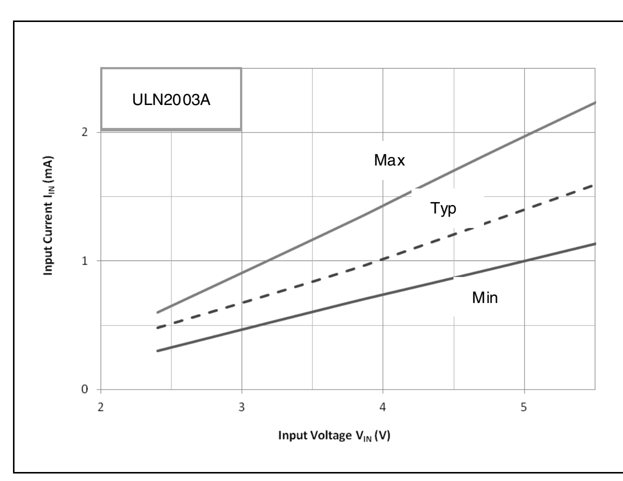


Figure 14. Input current vs. input voltage (Ta = 25°C)

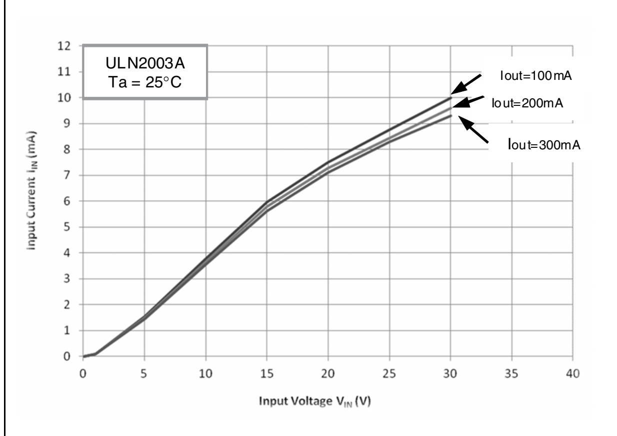


Figure 15. Collector current vs. input current

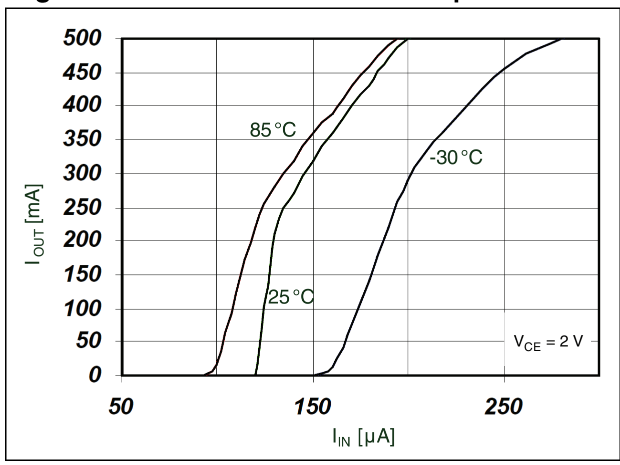


Figure 16. h_{FE} vs. output current

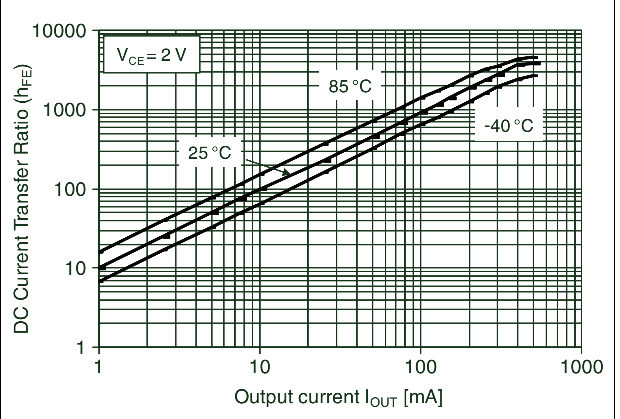


Figure 17. Peak collector current vs. duty cycle (DIP-16)

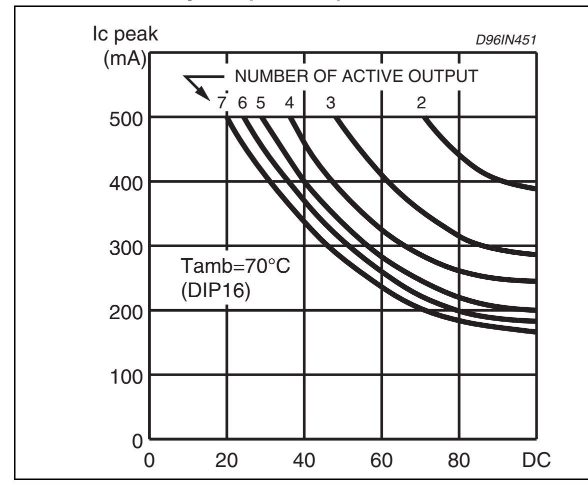
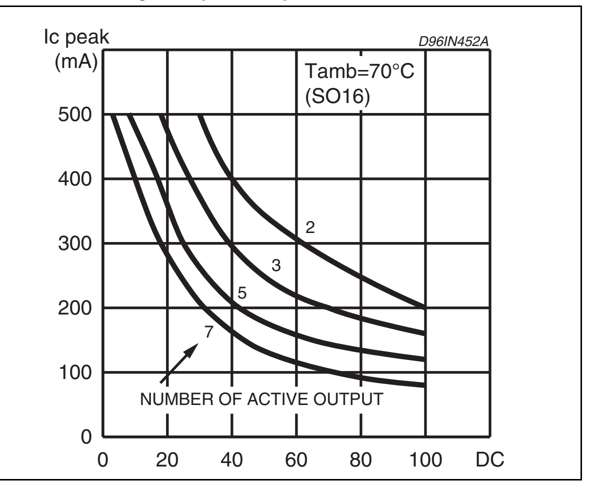


Figure 18. Peak collector current vs. duty cycle (SO-16)



7 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: *www.st.com*. ECOPACK® is an ST trademark.

Table 5. DIP-16L mechanical data

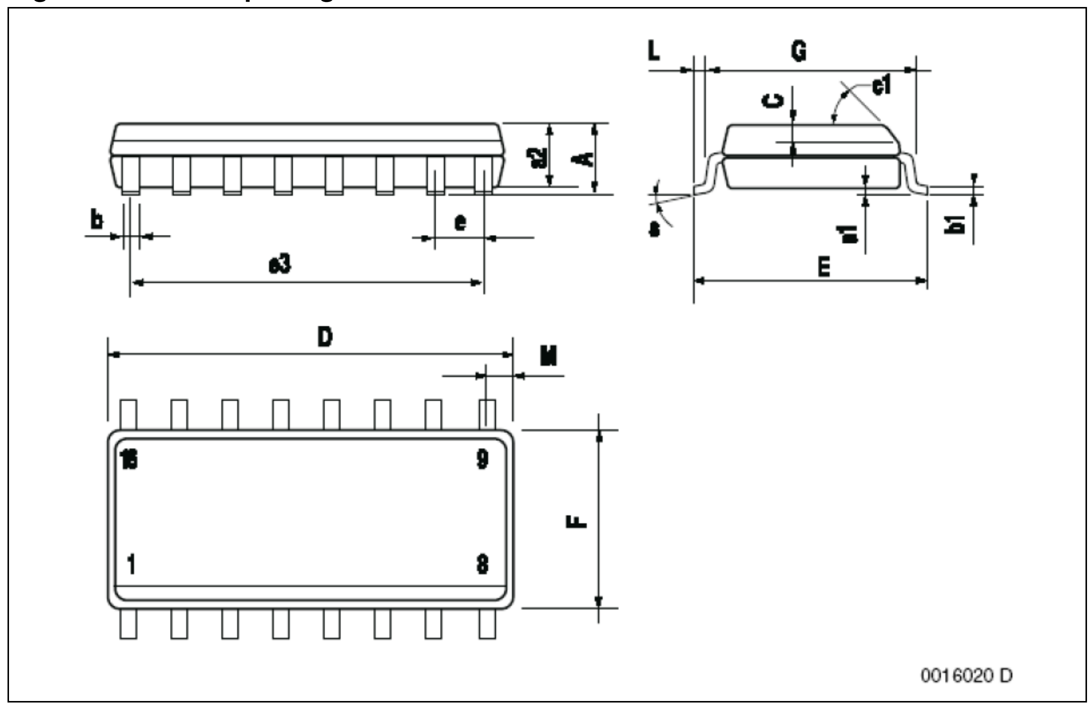
Dim.	mm.		
	Min.	Typ.	Max.
A			5.33
A1	0.38		
A2	2.92	3.30	4.95
b	0.36	0.46	0.56
b2	1.14	1.52	1.78
c	0.20	0.25	0.36
D	18067	19.18	19.69
E	7.62	7.87	8.26
E1	6.10	6.35	7.11
e		2.54	
e1		17.78	
eA		7.62	
eB			10.92
L	2.92	3.30	3.81

Figure 19. DIP-16L package dimensions

Table 6. SO-16 narrow mechanical data

Dim.	mm.			inch.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1	0.1		0.25	0.004		0.009
a2			1.6			0.063
b	0.35		0.46	0.014		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.020	
c1			45°	(typ.)		
D(1)	9.8		10	0.386		0.394
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		8.89			0.350	
F(1)	3.8		4.0	0.150		0.157
G	4.60		5.30	0.181		0.208
L	0.4		1.27	0.150		0.050
M			0.62			0.024
S	8° (max.)					

Figure 20. SO-16 package dimensions



8 Order codes

Table 7. Order codes

Part numbers	Packages
ULN2001A	DIP-16
ULN2002A	DIP-16
ULN2003A	DIP-16
ULN2004A	DIP-16
ULN2001D1013TR	SO-16 in tape and reel
ULN2002D1013TR	SO-16 in tape and reel
ULN2003D1013TR	SO-16 in tape and reel
ULN2004D1013TR	SO-16 in tape and reel

9 Revision history

Table 8. Revision history

Date	Revision	Changes
05-Dec-2006	5	Order code updated and document reformatted.
28-Aug-2007	6	Added *Table 1* in cover page.
07-May-2012	7	Modified: *Figure 12 on page 9*. Added: *Figure 13*, *14*, *15* and *Figure 16 on page 9*.
01-Jun-2012	8	Updated: DIP-16L package mechanical data *Table 5 on page 11* and *Figure 19 on page 12*.

